Analyst Forecast Dispersion, R&D and Stock Returns: Evidence from the UK

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Abstract

Existing literature has documented that R&D expenses have a statistically significant influence on subsequent stock returns, and that R&D intensive firms are characterized by significant excess risk-adjusted market returns. The study examines whether these R&D-related effects on returns are robust to controlling for analyst forecast dispersion, decomposed into a pure lack of consensus and forecast uncertainty component, according to Barron *et al* (1998). Information received from R&D expenses is expected to be non-exhaustive of the risk and uncertainty arising from R&D investments, regarding the future economic performance of R&D intensive firms. This is first because of a mismatch in expected future costs and benefits from R&D, due to the expensing of such costs. In addition, R&D investments are inherently characterized by very high uncertainty of future benefits. Thus, controlling for forecast uncertainty and consensus is considered necessary because these analyst forecast characteristics are expected to capture additional R&D-related economic information with a possibility to affect stock returns, compared to R&D expenses. At the same time, forecast dispersion and/or its components *per se* have been significantly associated with stock returns as well. The study documents that significant excess returns of R&D intensive firms observed by prior literature generally disappear upon controlling for forecast uncertainty and lack of consensus. The study contributes to prior literature by providing for the first time evidence that the existence of significant excess returns for high R&D firms no longer represents a deviation from market efficiency, upon implementing more controls for R&D-related information deficiencies.

1. Introduction

A number of studies have examined the relation between R&D and market performance by adding an R&D factor to the traditional Fama and French (1992, 1993) three factor model (e.g. Lev and Sougiannis, 1999 for the US; Al-Horani *et al*, 2003 for the UK). Upon inclusion of this fourth factor in the model, in the case of R&D intensive firm portfolios, prior literature documents a strong statistical significance of this factor, and an increase in the overall explanatory power of the model.

All these studies have not controlled for the influence of analyst disagreement on returns. Analyst forecast dispersion, which should be decomposed, according to Barron *et al* (1998) and Doukas *et al* (2006), into a pure divergence of opinions (or lack of correlation across analyst forecast errors) and a forecast uncertainty component, has been identified by prior literature to have a statistically significant influence on stock returns (Diether *et al*, 2002 for forecast dispersion; Doukas *et al*, 2006 for pure lack of consensus and forecast uncertainty). In addition, especially in the case of R&D intensive firms, prior literature has documented that R&D intensity is associated with distinct forecast dispersion characteristics: increased forecast dispersion, as well as higher lack of consensus and higher forecast uncertainty (Chambers *et al*, 2001; Barron *et al*, 2002).

The R&D factor, as has been used by prior literature to examine the influence of R&D intensity on stock returns, has been constructed by making use of realized R&D expenses, and returns from firm portfolios with differences in the intensity of these expenses across firms. Information stemming from R&D expenses is expected to be non-exhaustive of the risk and uncertainty arising from R&D expenditures, regarding the future economic performance of firms for a number of reasons. These reasons mainly relate to a mismatch in the expected future costs and benefits arising from R&D, due to the accounting treatment of expensing, as well as to the inherent very high uncertainty of the future benefits of the investment by construction (Lev, 2001).

The study examines whether the significant influence of R&D on returns, and the existence of significant excess returns for R&D intensive firms is robust to controlling for analyst forecast dispersion, and its components (pure lack of consensus and forecast uncertainty according to Barron *et al*, 1998). This control is considered necessary because accounting for forecast uncertainty and consensus is expected to capture additional R&D-related economic information, not incorporated by simply accounting for the impact of R&D intensity on returns, as done by prior studies. In that sense, the study assesses whether the R&D effect on returns is robust to these controls, at the same time when dispersion and/or its components *per se* have been empirically associated with stock returns in a significant way. The examination of this research question receives additional motivation by the observation that the inclusion of an R&D factor in the traditional three factor Fama and French model does *not* eliminate the positive and significant excess returns of R&D intensive firms, indicating that not all R&D-related information has been incorporated by the regression model.

The paper is organized as follows: Section 2 presents the theoretical background of the study and the research motivation. Section 3 describes the sample selection process and a summary of the methodology. Section 4 contains the empirical results, Section 5 discusses the empirical findings, and the study concludes with Section 5, which also summarizes the study limitations.

2. Theoretical Background and Research Motivation

2.1 Prior Literature on Analyst Disagreement and Stock Returns

Diether *et al* (2002) initially take a nondirectional approach regarding whether forecast dispersion should have a positive or negative impact on returns. Given that they testify a negative association between dispersion and returns, they deduct that dispersion is *not* a risk proxy: had dispersion been a risk proxy, *more* dispersion should be associated *positively*, and not *negatively*, as they find, with market performance. On the other hand, Doukas *et al* (2006) criticize the use of forecast dispersion by Diether *et al* (2006) as a proxy for analyst divergence of opinion. They argue, in line with Barron *et al* (1998), that dispersion consists of two parts: a pure analyst lack of consensus component, defined as lack of correlation across analyst forecast errors, and a forecast uncertainty component. Doukas *et al* (2006) testify a positive association between analyst pure lack of consensus and returns, which they interpret as evidence on risk compensation by the market, in a sense that lower analyst consensus implies higher risk, risk for which the market is found to compensate though higher returns. They testify a negative association between forecast uncertainty and returns, which they interpret as evidence that the market penalizes firms for bearing higher uncertainty. They therefore conclude that the Diether *et al* (2002) results on a negative association between dispersion and returns, could be in fact driven by the uncertainty component of forecast dispersion.

2.2. R&D and Stock Returns

There exist studies which have added an R&D factor to the traditional Fama and French (1992, 1993) three factor model (see Lev and Sougiannis, 1999 for the US; Al-Horani *et al*, 2003 for the UK), in an effort to analyze the association between R&D investments and subsequent stock returns. The addition of a factor to capture R&D-related effects on stock returns has been justified because: other factors in the model (e.g. the book-to-market factor) may not capture R&D-related innovation risk, or, the accounting treatment of R&D (expensing) might create intangible assets, recognised by the market but not incorporated within accounting figures (Al-Horani *et al*, 2003, Lev and Sougiannis, 1999). Upon inclusion of this fourth factor in the model, in the case of R&D-expense reporting firms, this literature has documented a significant influence of R&D intensity on the formation of stock returns, as well as the existence of positive and significant excess returns for high R&D firms. In other words, even after including an R&D

factor in the Fama and French three factor model, there have been still observed significantly positive excess returns for high R&D firms. Additionally, there has been observed a change in the behaviour (reduced significance) of the book-to-market factor for high R&D firms when the R&D factor is included (Al-Horani *et al*, 2003, Lev and Sougiannis, 1999).

2.3 Research Hypothesis Development

Analyst divergence of opinions, defined in most detail by making use of its two components as in Barron *et al* (1998) and Doukas *et al* (2006), is expected to capture firm-specific information not captured by all other factors included in the regression model used by Al-Horani *et al* (2003), including beta, size (market value of equity-MVE), the book-to-market factor (BM) and the R&D factor. This is because the R&D factor, as has been used by prior literature, has been constructed by making use of realized R&D expenses, and returns from firm portfolios with differences in the intensity of these expenses across firms. Information stemming from R&D expenses is expected to be non-exhaustive of the risk and uncertainty arising from R&D expenditures regarding the future economic performance of firms for a number of reasons.

First, such information does not give the users of financial statements indications on R&D-related matching of expected costs and benefits (Oswald and Zarowin, 2007), and thus increases the amount of uncertainty over the success of undertaken R&D projects and its expected timing. Second, by definition the R&D investment is a risky investment, associated with uncertain future benefits and also characterized by non tradability (Lev, 2001): there is little assurance over the economic success of relevant outlays, and consequently future earnings and cash flows associated with the success of such projects The fact that intangible investments, such as R&D, are nontradable in nature, also makes their true value uncertain (Lev, 2001). Third, as discussed in Al-Horani *et al* (2003), R&D may result in the creation of intangible assets, reflected in market values, but not incorporated within accounting earnings, as a result of accounting regulation (expensing). Had the R&D regressor added in the Fama and French model to explain returns been exhaustive of *all R&D-related information* able to affect returns, the inclusion of this R&D factor in the model for high R&D firms should make significant excess returns non-existent for these firms. This is not the case though, for these firms, as prior literature has testifies significant returns in their case even after including the R&D factor in the model (e.g. Al-Horani *et al*, 2003). In that sense, this prior evidence is interpreted as an indication that the inclusion of the R&D factor does not capture all sources of risk and uncertainty arising from undertaking R&D activities for high R&D firms.

On the other hand, the inclusions of controls for forecast uncertainty and consensus, when analyzing the association between R&D and market performance, is expected to capture information not included in the R&D factor that has been added to the Fama and French model to improve model specification. Analysts are expected to complement for financial statement information deficiencies which relate to R&D with information they get from their own personal research (Amir *et al*, 2003). As Amir *et al* (2003) underline, analysts communicate with corporate officials and complement financial statement information with information arising from their own company and sector research. In this case, uncertainty in analyst forecasts may be an indication of true economic uncertainty for the future outcome of a firm. At the same time, lack of correlation across analyst forecast errors or pure lack of consensus, an indication for risk according to Doukas *et al* (2006), may in its turn provide a more accurate idiosyncratic risk indication about the future outcome of R&D. This way, it is expected that accounting for analyst pure lack of consensus and forecast uncertainty, when analyzing the relation between R&D and returns, could improve R&D-related information deficiencies. The study aims at examining for the first time whether R&D effects on returns are robust to controlling for forecast uncertainty or consensus, given that these latter factors are expected to capture additional R&D-related economic information, not captured by the addition of an R&D factor in the traditional Fama and French model as done by prior studies in the field (e.g. Al-Horani *et al*, 2003, Lev and Sougiannis, 1999).

2.4 Choice of the UK Market as the Sample

The study is conducted for the UK market between 1990-2003 (moving to 2004 with return calculation), using data before International Financial Reporting Standard (IFRS) introduction to ensure a uniform accounting environment, and makes use of R&D expenses taken from the income statement. In the UK, even before International Accounting Standard 38 was introduced, SSAP 13 mandated the immediate expensing of research costs, when there was room for conditional capitalization for development costs, upon meeting certain criteria. Although development cost capitalization is not widely used in practice in the country (Green *et al*, 1996; Al-Horani *et al*, 2003), this accounting regulation ensures an accounting environment in which expensed R&D should in theory not be expected to lead to future benefits with expected technical and commercial feasibility. All development expenditures with a proven possibility to lead to future benefits can be excluded from the income statement according to UK accounting standards. This way, all income statement R&D used in the study should reflect solely research and development expenditures with unproven benefits to the future economic condition of the firm. Income statement R&D expense represents this way a variable with a more uniform economic nature of the expenditures included in it, compared to income statement R&D which would include all research and development expenditures, regardless of their technical and commercial feasibility. These characteristics of the UK context justify the use of the UK market for the examination of the research question.

3. Sample and Methodology

3.1 Sample Selection Process

In this study, there are used all UK listed (in both the London Stock Exchange and the Alternative Investment Market) non-financial firms for the period 1990-2003 (moving to 2004 with return calculation). The revised SSAP 13, which makes mandatory the disclosure of the amount of R&D expensed on the income statement, was introduced in the UK for accounting periods beginning on or after the 1st of January 1989, and there is therefore taken 1990 as the starting year in the analysis. The study period ends before IFRS implementation in 2005, to ensure a uniform accounting environment with respect to all financial statement figures employed.

Firms have been identified through the London Share Price Database (LSPD-Version 2003). Data on analyst earnings forecasts, actual reported earnings and financial year ends have been taken from IBES. Accounting figures have been taken from Worldscope, and information on stock returns and market values has been taken from Datastream. For a firm to be included in the study, there must exist data on the book-to-market ratio (BM), market value of equity (MVE), sales and total assets (TA) at year end, and have at least one observation of one year ahead forecasted earning during the twelve months before financial year end, as well as a figure for actual reported earnings from IBES for the particular year. One year ahead EPS forecast data are used.

In the UK, accounting years end at different times during the calendar year. This implies that calculating, for example, one month prior to year end analyst forecast dispersion for the sample firms would require the use of dispersion data taken at different calendar months for different firms. The study, though, requires the use of returns as well as analyst forecast data and accounting data in order to link forecast dispersion characteristics with market performance. For reasons of consistency, returns should be covering the same time windows for all firms. The problem of different months for accounting year ends is inherent in all type of empirical research for the UK, which makes use of both accounting and market based data. In order to avoid the problem of aligning monthly returns with dispersion measures due to different fiscal year ends, only those firms with a December fiscal year end have been used for sample selection purposes. This resulted in a significant reduction in the number of observations used in the study, but on the other hand insures consistency in forecast-return alignment across firms.

There study uses the FTSE Actuaries industry classification, which is additionally followed by LSPD. The study makes use of R&D expense taken from the income statement, which should include, according to SSAP 13, research costs and development costs which cannot be recognized as assets. As discussed, although the dominant practice in the country is to immediately expense all of R&D, the choice of income statement R&D in specific ensures the use of a variable as uniform in terms of economic nature as possible[1].

The above sample selection process results in a total of 4,361 firm-year observations (697 firms) for the period 1990-2003, out of which 38.11% report an R&D expense (1,662 firm-year observations and 274 firms)[2]. Increased R&D reporting is concentrated in the sectors one would expect, that is Information Technology Software and Hardware, with percentages around 90 and 60% respectively (untabulated data), as well as Electronics and Engineering (64.7 and 68.8% respectively) and Health and Pharmaceuticals and Biotechnology (83.7 and 77.9% respectively). Following prior literature on R&D and market performance (e.g. Al-Horani *et al*, 2003, Amir *et al*, 2003), in the tests that involve market performance R&D intensity is defined as R&D expense from the income statement divided by market value of equity (R&D/MVE).

R&D intensity expressed in terms of R&D/MVE (and R&D/Sales) has increased steadily from around 1%, in terms of median values, in 1990 to around 4% in 2003 (untabulated data).

[1] In the sample only 2.7% of firm-year observations report capitalized development costs on the balance sheet, and 2.2% of firm-year observations report amortized development costs on the income statement (6.4% and 5.5% of firms respectively) when using the full sample – all firms that meet the sample selection criteria regardless of fiscal year end (Extel Database items EX.FixedAssetsDevelopCostsGross and EX.FixedAssetsDevelopCostsAmort) In addition, the study does not perform R&D capital calculation since this would make necessary the use of lagged R&D values, and the sample period starts in 1990 and only covers 13 years. There has been therefore applied the methodology by Al-Horani *et al* (2003) by estimating Pearson correlation coefficients between yearly R&D expense and estimated R&D capital for the period 1994-2003. Given the high Pearson coefficient values observed (even after deflating R&D variables by sales, total assets and market value of equity), it is assumed that yearly R&D expense is a good proxy for firm R&D activity and the study makes no use of calculated R&D capital.

[2] Had been used all firms that meet the sample selection criteria regardless of fiscal year end, the sample selection process would have resulted in 10,653 firm-year observations (1,647 firms) for the period, out of which 35.69% report R&D (3,802 firm-year observations and 610 firms).

For both R&D intensity ratios mentioned above, the breakpoint for the top 20% of firms started from around 3 to 5% for 1990 to end at 20% for R&D/Sales and about and 9% for R&D/MVE at the end of the sample period. This trend is not testified for the median values of the ratios. There is also observed an increase in the values of both R&D/Sales and R&D/MVE ratios from 1999 onwards, covering the time period of the New Economy years. Calculating R&D intensity as R&D/TA (untabulated data) does not cause any change in the direction of the trends.

4. Empirical Findings

4.1 Analyst Forecast Dispersion, Analyst Divergence of Opinions and Analyst Forecast Uncertainty According to R&D Intensity

Forecast dispersion is defined as the standard deviation of one year ahead analyst forecasts for a particular company for a specific month (given by IBES), standardized by the absolute value of the one year ahead mean analyst forecast for this company for that month. The standardization procedure follows Diether *et al* (2002). To avoid outliers, dispersion observations below the 0.02 and above the 0.98 percentile have been eliminated. There are used minus one month prior to year end one year ahead forecasts for dispersion calculation.

As a first step, the study assesses analyst forecast dispersion for the whole sample, R&D firms, zero R&D firms and according to R&D intensity quartiles, defined using R&D/Sales and R&D/MVE. Quartiles are rebalanced annually. Table 1 Panel A shows the average dispersion in analyst forecasts for the whole sample, the R&D firms, the zero R&D firms and according to R&D intensity quartiles during the sample period. As can be observed from the Table, zero R&D firms tend to exhibit slightly higher dispersion than R&D firms, a fact that could be receive influence by the higher number of observations without R&D compared to observations of R&D reporting firms. Consistent with prior literature (e.g. Chambers *et al*, 2002), among R&D firms the higher R&D intensity quartiles exhibit higher dispersion compared to the lower ones, and the highest R&D intensity quartile exhibits by far the highest dispersion, no matter which R&D intensity proxy is used. Without controlling for other factors, the top R&D intensity quartiles exhibit dispersion values above 0.14, compared to the bottom intensity quartile, with values below 0.10, following steady increases as we move from lower to higher intensity quartiles[3].

Insert Table 1 here.

The accuracy of forecast dispersion as a measure of differences of opinion among analysts has received severe criticism by prior literature. In specific, Doukas *et al* (2006) argue that forecast dispersion is actually the result of both uncertainty and differences of opinion, following the definition of dispersion given by Barron *et al* (1998). They consider forecast dispersion to be an inaccurate proxy for analyst disagreement, since it receives influence from forecast uncertainty. In order to be consistent with all aspects of the matter examined by prior literature, the study has also used a different definition of dispersion following conceptually Barron *et al* (1998) and Doukas *et al* (2006). Dispersion is decomposed into a differences of opinion (or pure lack of consensus) (1- ρ) component (with ρ to be the correlation of forecast errors across analysts, a measure of analyst consensus) and a forecast uncertainty (V) component. This way $D = V*(1-\rho)$, where $\rho = h/(h+s)$, and $V=D/(1-\rho)$, with h=precision of common information and s=precision of idiosyncratic information and $h=(SE-(D/N))/((SE-(D/N))+D)^2$, $s=D/((SE-(D/N))+D)^2$.

SE is the squared error of the mean forecast (deflated by the absolute value of mean EPS forecast), and N is the number of forecasts. For (1-ρ) and V calculation, in the formula $V=D/(1-\rho)$, D is the variance in forecasts (deflated by the absolute value of mean EPS forecast) =

[3] At this point, one could argue that a firm's dispersion in analyst forecasts depends on the number of analysts that produce forecasts for this firm, and therefore a firm that is covered by more analysts will tend to exhibit higher dispersion in its earnings forecasts. In order to control for this limitation, the analysis on Table 1 has been repeated (for firms regardless of the month of fiscal year end) after including only the firms for which the forecasted EPS is produced by five or more analysts (untabulated results), and there was observed no qualitative difference on the direction of the results. In addition, calculating R&D intensity as R&D/TA (untabulated data) does not cause any change in the direction of the results.

((standard deviation in forecasts) * (standard deviation in forecasts)/(absolute value of mean EPS forecast)) * 10. In other words, D in the formula used for (1-ρ) and V calculation is the scaled variance of analyst forecasts (squared standard deviation or squared dispersion presented in Table 1 Panel A)- multiplied by 10[4].

There is reported on Table 1 Panel B the average V and (1-ρ), calculated using minus one month one year ahead EPS forecast data prior to year end, for the whole sample, the R&D and zero R&D firms and according to R&D/Sales and R&D/MVE quartiles for the R&D firms separately.

What is observed from the results in Table 1 Panel B is that analyst forecast dispersion, without controlling for other factors, should be more driven by uncertainty and not by differences of opinion. As R&D intensity increases, V and not (1-ρ) steadily increases as well from. The lack of consensus component appears even to slightly decrease as R&D intensity increases from values around 0.7 to values around 0.6. Calculating R&D intensity as R&D/TA does not cause changes in the directions of the results (untabulated data)[5].

4.2 R&D and Stock Returns: Fama-French Time-Series Regressions

To assess whether R&D effect on returns are robust to controlling for analyst consensus and forecast uncertainty, there is needed an empirical setting that accounts simultaneously for the impact of R&D intensity and all of these analyst forecast characteristics on stock returns. In

[4] This multiplication of D by 10 for 1-ρ and V calculation justifies the fact that in Table 1, if one multiplies V by 1-ρ the result does not equal D.

[5] In a previous version of the paper, to assess the statistical significance of R&D intensity on analyst forecast dispersion, there had been included regression analysis. Forecast dispersion was regressed on R&D intensity, controlling at the same time for the book-to-market factor, market value of equity, analyst following and past volatility of reported EPS. The regression was run for all firms regardless of financial year end. Overall findings suggested that R&D intensity was a contributing factor for analyst forecast dispersion in one year ahead earnings' forecasts, even after controlling for other firm characteristics. The findings were consistent with prior findings for the US on R&D intensity being positively associated with greater analyst dispersion (Chambers *et al*, 2002). The regression was then repeated by replacing the regressed variable of dispersion in analysts' forecasts by uncertainty in forecasts V and analyst lack of consensus (1-ρ). This analysis failed to produce consistently statistically significant results for the R&D variable, after controlling for other factors. This finding may probably be attributed to the observation that R&D intensity may influence dispersion in analysts' forecasts as a whole in a statistically significant manner, but not each of its components individually, after controlling for other factors. This way, the relation between R&D and the components of forecast dispersion is weaker compared to the influence of R&D on overall dispersion (untabulated data).

order to assess the impact of R&D on stock returns, among other methodologies, previous research has extensively used regression analysis, after controlling for Fama-French (1992, 1993) risk factors, which include firm size (market value of equity or MVE), the book-to-market ratio (BM), and market beta. Al-Horani *et al* (2003) provide a modification to the traditional Fama and French (1993) time-series model: in an attempt to capture the impact of R&D on returns, they construct and add among the regressors an R&D factor. This is constructed from the returns of R&D versus non R&D firms, which possess similar BM characteristics. When they run their Fama-French regressions with the addition of the R&D factor, they still observe statistically significant positive alphas for R&D intensive firm, and in the same direction are the findings of Lev and Sougiannis (1999) for the US. Diether *et al* (2002) and Doukas *et al* (2006) also use the time series Fama and French (1993) to assess the existence of statistically significant excess returns for different levels analyst disagreement and forecast uncertainty across firms.

In this study, in order to assess the influence of different degrees of analyst disagreement and forecast uncertainty in the presence of high R&D intensity, to be consistent with prior literature, there is also followed the Fama-French (1993) time series model. In order to account for the impact of R&D on returns, there is also added an R&D factor introduced by Al-Horani *et al* (2003) in the time-series regressions, given that the research question by construction involves valuation issues that relate to the R&D impact on returns. The empirical analysis begins by running Fama- French time series regressions, with the addition of the R&D factor, for the particular sample used in the study.

The reason for replicating the Al-Horani *et al* (2003) regressions for the specific sample used in the study before proceeding with the analyst diversion of opinions/forecast uncertainty and returns assessment is justified because of the unique sample is used. Al-Horani *et al* make use of all sample firms that meet their sample selection criteria regardless of fiscal year end whereas only December fiscal year end firms are used in this study. This way, it was considered necessary to calculate the relevant results before and after dispersion controls in order to be able to make the relevant comparisons using the data employed in *this study*.

With respect to the exact model construction, monthly excess returns for a total of 156 months, from July 1991 until June 2004 are regressed on the market factor, a size factor SMB, a value factor HML and additionally a factor that accounts for the effect of R&D on stock returns. For model construction purposes, up to a certain point the study follows quite closely the methodology by Al Horani *et al* (2003). The market factor is defined as the difference between the monthly value-weighted return of all the sample firms minus the risk free rate (1 month UK Treasury Bill rate). Then sample firms are divided into two size portfolios, using the median MVE as at the end of June of year t, and three BM portfolios, with BM calculated using book value for the accounting year that ended within the calendar year t-1 and MVE as at the end of December of year t-1. The lowest BM portfolio consists of the values of the lowest 30% of BM values, the mid BM portfolio includes the values of the mid 40% of values for BM and finally the top BM portfolio consists of the top 30% of firms. This procedure results in the construction of six (two by three) annually rebalanced size-BM portfolios, using the intersections of the MVE and BM portfolios: Small-low (SL: small MVE-low BM), small-mid (SM: small MVE-mid BM), small-high (SH: small MVE-high BM), big-low (BL: big MVE-low BM), big-mid (BM: big MVE-mid BM) and finally big-high (BH: big MVE-high BM). The SML factor is calculated by using the difference between the average monthly returns of three small and three large MVE portfolios: (SL+SM+SH)/3-(BL+BM+BH)/3. In the same direction, the value factor HML is defined as the difference between the average monthly returns between two high BM and two low BM portfolios: (SH+BH)/2-(SL+BL)/2. Following Diether *et al* (2002), all portfolio returns for the construction of the SMB and HML factors are equal-weighted. In order to allow for accounting data to become public, and also following prior literature to ensure comparability (Al-Horani *et al*, 2003), returns are taken from July in year t until June in year t+1 for annually rebalanced data that refers to the base year t (MVE as of the end of June t, BM with book value for the accounting year that ended within the calendar year t-1 and MVE as at the end of December at t-1).

Regarding the R&D factor, it is constructed as in Al-Horani *et al* (2003), by taking the difference between the average monthly returns of three R&D reporting BM portfolios (RD) and three zero R&D portfolios (ZRD): (LRD+MRD+HRD)/3-(LZRD+MZRD+HZRD)/3. The returns of their six R&D or ZERO R&D, low-mid or high BM portfolios are value weighted. In this study, there are employed equal instead of value weighted returns, since the analyst lack of consensus portfolios that will be calculated later in the study are also equal-weighted, following Diether *et al* (2002). In that sense, there is a need for consistency among the way to calculate portfolio returns for the construction of the variables in the right and left side of the regression equation.

The following regression is run using time series monthly data for a total of 156 months, from July 1991 until June 2004. The analysis is performed for all the sample firms, the R&D firms, the zero R&D firms, and the R&D firms according to R&D/MVE quartiles.

$$(Rp - Rf) = alpha + \beta_1 (Rm - Rf) + \beta_2 SMB + \beta_3 HML + \beta_4 RDFactor + \varepsilon$$

(1) where:

Rp-Rf- the difference between the equal-weighted monthly returns of the portfolio of firms in question each time and the risk free rate (1 month UK Treasury Bill rate). One year ahead analyst forecast data taken one month prior to year end are used for dispersion calculation.

Rm-Rf- the difference between the monthly value-weighted return of all the sample firms and the risk free rate (1 month UK Treasury Bill rate).

SMB- the size factor, calculated by using the difference between the average equal-weighted monthly returns of three small and three large MVE portfolios: (SL+SM+SH)/3-(BL+BM+BH)/3.

HML- the value factor, defined as the difference between the average equal-weighted monthly returns between two high BM and two low BM portfolios: (SH+BH)/2-(SL+BL)/2.

RD Factor- the factor that accounts for the difference in the returns of differing R&D intensity firms, calculated by taking the difference between the average monthly returns of three BM portfolios of R&D reporting firms and three BM portfolios of zero R&D firms: (LRD+MRD+HRD)/3-(LZRD+MZRD+HZRD)/3.

The time-series regressions are run using OLS and Whites Heteroskedasticity robust errors. Table 2 reports the coefficient estimates and values of t-statistics (in parentheses) for the regressions run with the addition of R&D factor for the whole sample, the R&D firms, the zero R&D firms, R&D firms according to R&D/MVE quartiles (from low to high), and finally R&D firms with an R&D/MVE ratio in the top R&D/MVE quintile.

Insert Table 2 here.

What can be observed from Table 2[6] is that the coefficients of the regressors tend to get signs and values of t statistics that conform to the findings by prior literature. With the exception of the value factor HML, the market factor and the size factor SMB get coefficients with positive signs and are very much statistically significant at the sample level, and for R&D and zero R&D firms separately. The value factor HML in the case of the R&D firms sometimes gets a negative sign and is not statistically significant at any reasonable level of significance for the R&D firms that belong to increasing R&D intensity quartiles. This result though in its turn is

[6] In a previous version of the paper, there were included regression results for all regressions run without the addition of the R&D factor in the regressions. In this version, to sharpen the focus of the study, there are presented only the regression results with the addition of an R&D regressor, to improve the focus of the paper on R&D-related valuation issues. Regression results without the addition of the R&D factor, which generally confirm previous literature findings in the field, are available upon request.

also consistent with prior literature, given that Lev and Sougiannis (1999) find indeed that the value factor is of limited overall significance for returns as R&D intensity increases.

The R&D factor is positive and significant for all R&D firms but for these R&D firms in the bottom intensity quartile. The values of the t statistics of the R&D factor coefficients show a steady upward trend as R&D intensity increases. There are not observed any statistically significant excess returns (alphas) at the sample level, for R&D, zero R&D and R&D firms which belong to the three lowest R&D intensity quartiles. In the case of firms in the top R&D intensity quartile, there is observed a positive and statistically significant alpha with a t statistic value of around 2.25, and the t statistics for the alpha are even higher - around 2.32 - for the firms in the top R&D intensity quintile. This finding is consistent with prior literature findings - despite the limited sample used using only firms with December year ends- on positive and statistically significant excess returns for R&D intensive firms (e.g. Chan *et al*, 2001, Al-Horani *et al*, 2003). Taking the findings from Table 2 as a whole, there is deduced that: 1. the R&D factor has a significant explanatory power for stock returns in the case of the R&D reporting firms, and, more pronounced, for R&D intensive firms and 2. There are observed significant alphas, indicating significant excess returns only in the case of R&D intensive firms.

4.3 Analyst Lack of Consensus, Forecast Uncertainty and Stock Returns for R&D Firms: Fama-French Time-Series Regressions

Previous analyses confirm prior literature findings on the existence of significant excess returns for R&D intensive firms, as well as on the significance of the R&D regressor in the case the R&D firms for the particular sample used in the study. The next steps involve controlling for the joint impact of analyst forecast dispersion and its components, pure lack of consensus and forecast uncertainty, on stock returns. The previous analysis is repeated for the R&D and R&D intensive firms that belong to different forecast dispersion (D), and then its components according to Barron *et al* (1998) -pure analyst lack of consensus (1-ρ) and analyst forecast uncertainty (V), portfolios. The reason for performing this analysis for the R&D and R&D intensive firms is because the R&D effects testified by previous studies (and by this study as well, for the particular sample used) involve these particular categories of firms: significant excess returns have been testified for R&D intensive firms, and the R&D regressor has been found to relate significantly to stock returns in the case the R&D expense reporting and R&D expense intensive firms.

The analysis begins by running Fama and French regressions for the R&D reporting firms, according to three forecast dispersion (D), analyst lack of consensus (1-ρ) and forecast uncertainty portfolios (V). The bottom dispersion portfolio contains the R&D firms with the lowest 30% of dispersion values, the mid dispersion portfolio contains the values of dispersion between 30 and 70% and the top dispersion portfolio consists of the firms with dispersion in the top 30% - the same portfolio construction rule applies to pure analyst lack of consensus and analyst forecast uncertainty portfolios. Dispersion and its components are defined as in Section 4.1. The reason for making use of three instead of five for example relevant portfolios is because the study makes use of a limited sample of firms with a December fiscal year end, and therefore there are needed enough firm year observations to make portfolio construction meaningful.

Dispersion (and its components) portfolios are annually rebalanced. In the case of Diether *et al* (2002), dispersion portfolios are monthly rebalanced, based on forecast dispersion data of the previous month for the assessment of returns in the current month. This paper though accounts for the R&D-impact on returns, and analyst forecast data are changing constantly, when R&D is an investment with an expected long term impact. R&D expense data are annually extracted from financial statements. Thus, making use of annual rebalancing for analyst forecast dispersion calculation assures consistency with the time intervals at which R&D expense data are taken. In order to make sure that analyst forecast data are as close as possible to return calculation, there are used analyst forecast data one month prior to (December) year end.

Table 3 Panels A, B and C contains the results on the coefficient estimates and values of the t-statistics when regressing returns on the market factor, SMB and HML, with the addition of the R&D factor in the model, for the R&D reporting firms. Table 3 Panel A contains the results after running the regression according to three dispersion portfolios (D), Panel B according to three analyst lack of consensus portfolios (1-ρ), and Panel C according to three forecast uncertainty portfolios (V). As can be observed from Table 3, Panel A, B and C, there is observed no great qualitative change in the direction of the results compared to the relevant results on Table 2 regarding the signs and statistical significance of the regressors, even after accounting for differences in forecast dispersion and its components among R&D firms. The market factor and SMB get positive and significant coefficients. HML is often negative and overall not statistically significant in the case of the R&D firms, especially for low D, (1-ρ) and V portfolios. The R&D factor gets a coefficient which is positive and significant in the case the R&D firms, especially as dispersion increases. This behaviour of the R&D factor is not observed to hold as steadily when controlling for analyst lack of consensus (1-ρ) or forecast uncertainty (V), but for most D, (1-ρ) and V portfolios, its coefficient is statistically significant. Most importantly, in no case are there observed any statistically significant excess returns in the form of significant alphas for any category of firms analysed when controlling for forecast dispersion or lack of consensus or forecast uncertainty. Under no circumstances are there observed any statistically significant alphas for particular analyst lack of consensus (1-ρ) and three analyst forecast uncertainty V portfolios for R&D firms, indicating this way no qualitative change in the direction for the results after controlling for forecast uncertainty and consensus for R&D reporting firms.

Insert Table 3 here.

The previous findings for R&D firms are conflicting to Doukas *et al* (2006), who testify a positive association between analyst lack of consensus and returns and a negative association between forecast uncertainty and returns for the US, without any assessment of R&D intensity. The findings on Table 3 are also in contrast to Diether *et al* (2002), who testify a negative association between forecast dispersion and returns again for the US, even after including an R&D regressor among Fama and French risk factors. There is therefore observed a conflict in the results on analyst disagreement and subsequent stock returns when comparing between the US and the UK, after accounting for the role of R&D on returns[7]. This way, contrary to US evidence, differences in analyst forecast dispersion, divergence of opinions or forecast uncertainty are *not* found to be associated with statistically significant returns, positive or negative, in the case of R&D firms.

4.4 R&D Intensive Firms, Analyst Consensus, Analyst Forecast Uncertainty and Excess Stock Returns: Fama-French Time-Series Regressions

Table 4 continues the analysis provided in Table 3, by examining whether R&D effects on stock returns are robust to controlling for analyst forecast dispersion and its components for the R&D intensive firms, which were the only ones to exhibit positive and statistically significant alphas, among the other categories of firms examined in Table 2.

In this case, the returns of the firms which belong to the top R&D/MVE quartile are regressed on the market factor, the size and value factor, with the inclusion of the R&D factor in the regressions, according to three analyst forecast dispersion (D - Table 4 Panel A), analyst lack of consensus (1-ρ - Table 4 Panel B), and analyst forecast uncertainty (V - Table 4 Panel C)

[7] The use of five instead of three forecast dispersion, lack of consensus, and forecast uncertainty portfolios does not cause any qualitative change in the direction of the results (analysis performed for all sample firms regardless of fiscal year end - untabulated data). In order to control for possible effects from the New Economy years on the results (late 1990's – early 2000), the regressions in Panel A of the Table 3 have been rerun by excluding the months from January 1999-December 2001 for all sample firms regardless of fiscal year end, with no significant qualitative changes in the direction of the results (untabulated data). Finally, running the regressions without an R&D factor among regressors as was done in a previous version of the paper did not cause any change in the direction of the results, and the existence of significant excess returns in specific (untabulated data).

portfolios. As before, the reason for making use of three instead of five for example relevant portfolios is because the study makes use of a limited sample of firms with a December fiscal year end, and therefore there is a need for enough firm year observations to make portfolio construction meaningful. The relevant results are reported on Table 4.

Insert Table 4 here.

As can be observed from Table 4, Panels A, B and C, the behaviour of the market factor, the size and value factors is more or less similar in terms of signs of the coefficients and their statistical significance compared to the relevant results on Table 2, in which case differences in analyst disagreement and forecast uncertainty had not been taken into account. Both the market factor and size factor generally get positive and very much statistically significant coefficients. The values of the coefficients of the market factor are well above one. The value factor HML is not consistently significant and not even positive in all regressions as analyst forecast disagreement changes, in all of Panels A, B and C, consistent with the findings on Table 2 for very R&D intensive firms. Regarding the R&D factor, this is again found to be generally statistically significant for R&D intensive firms across portfolios in all Panels A, B and C, with the exception of the lowest forecast uncertainty portfolio in Panel C. The values of the t statistics though for the R&D factor are quite lower compared to their values in Table 2, indicating a lower level of significance.

The most interesting observation has to do with the behaviour of excess returns or alphas across Panels A, B and C. In Panel A, where excess returns are assessed for R&D intensive firms according to three analyst forecast dispersion portfolios, statistically significant alphas disappear in terms of statistical significance for all dispersion portfolios. In other words, the previously observed positive excess returns of high R&D firms, present even after the inclusion of the R&D factor in the model, completely disappear when controlling for analyst forecast dispersion.

As forecast dispersion has received criticism (Doukas *et al*, 2006) to be an inaccurate measure of analyst disagreement (it may be influenced by forecast uncertainty and therefore not truly reflect pure divergence of opinions among analysts), Table 4 Panel B presents the results of the examination of the returns of high R&D firms according to three analyst pure divergence of opinions (1-ρ) portfolios. Interestingly, there are not observed again any significant excess returns for high R&D firms when pure divergence of opinions is medium or high. When pure analyst disagreement is low, alphas are found to be positive and very weakly significant.

Table 4 Panel C then presents the regression results when examining the existence of significant excess returns after controlling for analyst forecast uncertainty V (according to three V portfolios) for firms with an R&D intensity ratio in the top quartile. No significant excess returns are observed for high R&D firms when forecast uncertainty is medium or high. For the bottom uncertainty portfolio though, there are found positive and very much statistically significant alphas at 5% significance level. This way, R&D intensive firms with very low uncertainty V are the only ones found to exhibit statistically significant and positive excess returns.

Taking the findings from Table 4 as a whole, there is generally found no significant relationship between analyst disagreement (defined in the form of either forecast dispersion, or, more strictly, as pure lack of consensus/absence of correlation among analyst forecast errors), and subsequent market performance in the presence of high R&D intensity. In contrast, when examining whether R&D effects on returns are robust to controlling for forecast uncertainty, there is found that R&D intensive firms with low degrees of uncertainty are the only exhibiting superior market performance. This latter finding confirms a negative association between analyst forecast uncertainty and subsequent stock returns [8].

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[8] As a final robustness check, the study assesses whether the fact that standard deviation is scaled by the absolute value of the mean forecast drives the results, in sense that the mean analyst forecast may be associated with future stock returns and not the standard deviation in analyst forecasts: Following a previous such control by Diether *et al* (2002), annual stock returns (calculated with monthly data) were regressed on both dispersion, R&D intensity and

4.5 Summary of Results

Consistent with prior studies, the study testifies that an R&D factor added to the traditional Fama-French has a positive and significant influence on stock returns in the case of R&D firms. This result is more pronounced for R&D intensive firms, and for these firms, again consistent with prior literature, there are testified positive and significant excess returns, risk-adjusted for firm size and the book-to-market factor, even after the inclusion of the R&D factor in the model. The study proceeds by controlling for forecast uncertainty and consensus when analyzing the association between R&D and market performance: When running the Fama and French regression model by controlling for different degrees of analyst disagreement, with the addition of an R&D factor in the model, in the case of R&D firms, there is observed no significant influence of analyst disagreement on stock returns. In other words, different degrees of analyst disagreement, and its components (pure lack of consensus and forecast uncertainty), among R&D firms, were *not* found to alter in any way the results obtained prior to implementing these controls: the R&D factor continued to appear overall positive and significant.

In the case of R&D intensive firms, though, the implementation of these controls generally resulted in the previously testified significant excess returns for these firms to become statistically *not significant*. The previously observed significant excess returns of R&D intensive firms generally disappeared upon controlling for analyst forecast dispersion and its components, pure lack of consensus (or lack of correlation across forecast errors) and forecast uncertainty. Significant excess returns for high R&D firms at 5% significance level were documented only for these firms which exhibited very *low* degrees of forecast uncertainty, confirming this way a

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other control variables (past sales, mean EPS forecast, MVE and BM), for all firms, regardless of fiscal year end, and also repeated the analysis by replacing the dispersion independent variable with (1-ρ) and V (regressions run for the all sample firms regardless of month of fiscal year end – untabulated data available upon request). The results indicated a negative and statistically significant dispersion regressor, even after controlling for other variables, and V and (1-ρ) were of lower overall significance than dispersion (with negative sign) with V to exhibit stronger significance than (1-ρ). These results were robust to the inclusion of industry dummy variables and the particular regression setting actually permitted controlling for industry factors though the use of industry dummy variables.

negative association between uncertainty and returns (low uncertainty is 'rewarded' by the market with higher returns), as in Doukas *et al* (2006). The influence of the R&D expense on returns (R&D factor) continued to be generally statistically significant after implementing controls for forecast uncertainty and consensus, but for almost all R&D intensive firm portfolios (with the exception of the one just described), there were no longer observed significant excess returns for R&D intensive firms.

5. Discussion of Results

The study findings are interpreted as evidence that controlling for analyst disagreement, defined even in its stricter terms as lack of correlation among analyst forecast errors (as in Barron *et al*, 1998 and Doukas *et al*, 2006), and forecast uncertainty, shakes the robustness of significant risk-adjusted excess returns for high R&D firms documented by prior literature. After controlling for the impact of R&D on returns for high R&D firms, as well as forecast uncertainty and consensus, these firms are *not* found to exhibit significant excess returns any longer. It is, thus, considered that, conforming to the research hypothesis, implementing controls for analyst forecast disagreement and uncertainty could improve R&D-related information deficiencies for R&D intensive firms. If uncertainty in analyst forecasts is an indication of the true economic uncertainty over the future outcome of a firm intensive in R&D, and if the lack of correlation across analyst forecast errors is an indication of relevant risk according to Doukas *et al*, the incorporation of this information in the model could provide a more accurate idiosyncratic risk and uncertainty indication about the future outcome of R&D.

This is because investments in R&D, resulting from a poor accounting mismatch between investment-related future costs and benefits, or due to the great uncertainty of the future benefits of the investment *per se*, pose difficulties in capturing their true economic benefits within the previously used factors in the regression model. This way, the controls implemented by the study are seen as a possibility to account for R&D-related information deficiencies when analyzing the relationship between R&D and returns. The study contributes to existing literature by providing an indication for the first time that significant excess returns for high R&D firms no longer represent a deviation from market efficiency, upon implementing enough controls for R&D-related information deficiencies in the model.

6. Conclusion

The study examines whether the empirically testified significant influence of R&D on returns, and the existence of significant excess returns for R&D intensive firms is robust to controlling for analyst forecast dispersion, and its components (pure lack of consensus and forecast uncertainty according to Barron *et al*, 1998). Implementing this control for forecast uncertainty and consensus is expected to capture additional R&D-related economic information, not incorporated by simply accounting for the impact of R&D expense intensity on returns as done by prior studies. This way, the study assesses for the first time whether the R&D effect on returns is robust to these controls. The examination of this research question receives additional motivation by the empirical observation that the inclusion of an R&D factor in the traditional three factor Fama and French model does *not* eliminate the positive and significant excess returns of R&D intensive firms, indicating that not all R&D-related information has been incorporated by the regression model.

The examination of the research question is performed for the UK market during 1990-2003. The selection of UK as the sample market can be justified since accounting rules in this country have permitted the conditional capitalization of development costs even before IFRS introduction in 2005. Given this regulation, all income statement R&D used should reflect research and development expenditures with unproven benefits to the future economic condition of the firm, which cannot be capitalized as assets. Income statement R&D expense represents this way a variable with a more uniform economic nature of the expenditures included in it, compared to income statement R&D which would include all research and development expenditures, regardless of their technical and commercial feasibility, if accounting rules had imposed immediate expensing for all R&D costs.

The study finds that significant excess returns of R&D intensive firms observed by prior literature generally disappeared upon controlling for analyst forecast dispersion and its components, pure lack of consensus (or lack of correlation across forecast errors) and forecast uncertainty. Significant excess returns for R&D intensive were documented only for these firms which exhibited very *low* degrees of forecast uncertainty, confirming a negative association between uncertainty and returns. The influence of the R&D expense on returns (R&D factor) has been found to be generally statistically significant after implementing these controls, but for almost all R&D intensive firm portfolios, there were no longer observed significant excess returns for R&D intensive firms.

The study findings are interpreted as evidence that controlling for analyst lack of consensus, and forecast uncertainty, puts in question the robustness of significant excess returns for high R&D firms documented by prior literature. The controls implemented are seen as a possibility to account for R&D-related information deficiencies when analyzing the relationship between R&D and returns. The study contributes to prior literature by providing for the first time evidence that the existence of significant excess returns for high R&D firms no longer represents a deviation from market efficiency, upon implementing enough controls for R&D-related information deficiencies.

As a final comment, there should be mentioned that the paper may suffer from a by construction possible limitation due to the fact that it employs a limited sample, consisting only of those firms with a month of December financial year end. The reason for limiting the sample only to those firms relates to the need to align analyst forecast data with returns, since financial years end throughout the calendar year in the UK. This methodological difficulty resulted in employing a sample smaller than it would have otherwise been for reasons of proper alignment and it is therefore mentioned as a study limitation.

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Table 1

One year ahead analyst forecast dispersion, lack of consensus and forecast uncertainty according to R&D intensity

Panel A shows the average Sample period dispersion for the whole sample, R&D, zero R&D firms and according to quartiles formed by R&D/Sales and R&D/MVE (from low to high) – firms with a December fiscal year end. Dispersion is defined as the standard deviation in analyst forecasts divided by the absolute value of the mean forecast in the specific month. Observations below the 0.02 and above the 0.98 percentile have been eliminated. There are used forecasts one month prior to year end.

After decomposing forecast dispersion D in an uncertainty part (V) and a differences of opinion part (1-ρ) (definitions presented in Section 4.1), following Doukas *et al* (2006), Panel B reports V and (1-ρ) where V =D/(1-ρ), for the whole sample, the R&D and zero R&D firms, and R&D firms according to R&D/Sales and R&D/MVE quartiles. For V and (1-ρ) calculation, D= ((standard deviation in forecasts) *(standard deviation in forecasts)/(absolute value of mean EPS forecast)) *10, with the standard deviation of forecasts to be the one used for dispersion calculation, ρ =h/(h+s), V=D/(1-ρ), where h=precision of common information and s=precision of idiosyncratic information, $h=(SE-(D/N))/((SE-(D/N))+D)^2$, $s=D/((SE-(D/N))+D)^2$. SE = squared error of the mean forecast (deflated by the absolute value of actual EPS at year end), D= defined right above as the scaled variance of analyst forecasts multiplied by 10, N = the number of forecasts.

Observations below the 0.02 and above the 0.98 percentile have been eliminated. Minus one month prior to year end forecast data have been used for V and (1-ρ) calculation.

Panel A:	Dispersion	Panel B: Uncertainty V	Lack of Consensus (1-ρ)
Sample	0.124	1.191	0.685
R&D firms	0.112	1.101	0.651
Zero R&D firms	0.132	1.254	0.708
R&D/Sales			
Low	0.095	0.638	0.674
	0.112	0.868	0.647
	0.101	1.325	0.694
High	0.144	1.675	0.574
R&D/MVE			
Low	0.091	0.475	0.713
	0.080	0.882	0.627
	0.135	1.111	0.649
High	0.148	2.182	0.604

Table 2

Excess returns for the whole sample, R&D, zero R&D firms and R&D firms with different R&D intensities using Fama-French time-series regressions

The table reports the coefficient estimates and values of t-statistics (in parentheses) that have been estimated by running the following time-series regression using monthly data from July 1991-June 2004: (Rp-Rf) = alpha+ β_1(RM-Rf)+ +β_2SMB+β_3HML+β_4RDFactor+ε. Rp equals the equal-weighted monthly returns of the whole sample firms (with a December fiscal year end), then R&D firms, zero R&D firms, R&D firms according to R&D/MVE quartiles (from low to high), and finally R&D firms with an R&D/MVE ratio in the top R&D/MVE quintile (Rp-Rf) equals the difference between the equal-weighted monthly returns of the portfolios described above and the risk free rate (1 month UK Treasury Bill rate). (RM-Rf) equals the difference between the monthly value-weighted return of all the sample firms and the risk free rate. SMB equals the size factor, calculated by using the difference between the average equal-weighted monthly returns of three small and three large MVE portfolios: (SL+SM+SH)/3-(BL+BM+BH)/3. HML equals the value factor, defined as the difference between the average equal-weighted monthly returns between two high BM and two low BM portfolios: (SH+BH)/2-(SL+BL)/2. The R&D factor is calculated by taking the difference between the average monthly equal-weighted returns of three R&D reporting BM portfolios and three zero portfolios: (LRD+MRD+HRD)/3-(LZRD+MZRD+HZRD)/3. The regressions are run using OLS and Whites Heteroskedasticity robust standard errors. In the last column appear the F statistics and their p-values.

	alpha	RM	SMB	HML	RD Factor	Adj. R-squared	F-statistic
Sample	0.0006	1.1573	0.8117	0.0027	-0.1373	0.7566	121.4397
	(0.2952)	(17.8998)	(11.8843)	(0.0371)	(-1.3529)		(0.0000)
R&D firms	0.0002	1.1474	0.7003	0.0234	0.5127	0.7686	129.7425
	(0.1144)	(18.2064)	(10.4006)	(0.3210)	(5.0106)		(0.0000)
Zero R&D firms	0.0009	1.1600	0.8564	-0.0053	-0.3951	0.7586	122.7609
	(0.4083)	(17.5762)	(12.3253)	(-0.0738)	(-3.8540)		(0.0000)
R&D/MVE in bottom quartile	-0.0022	1.1416	0.3186	0.0873	0.0946	0.7337	107.7736
	(-0.9472)	(17.8836)	(4.0967)	(1.1257)	(0.8135)		(0.0000)
R&D/MVE in second quartile	-0.0003	1.0685	0.4433	-0.0591	0.3568	0.6704	79.8084
	(-0.1099)	(15.3079)	(5.8997)	(-0.6275)	(3.1108)		(0.0000)
R&D/MVE in third quartile	-0.0031	1.1981	0.7322	0.0385	0.6480	0.6449	71.3703
	(-1.0507)	(13.8025)	(7.0870)	(0.3542)	(3.6472)		(0.0000)
R&D/MVE in top quartile	0.0066	1.1888	1.3439	0.0162	0.9657	0.7149	98.1521
	(2.2467)	(14.7276)	(11.0118)	(0.1573)	(5.8531)		(0.0000)
R&D/MVE in top quintile	0.0075	1.1451	1.4075	-0.0988	1.1668	0.6858	85.5969
	(2.3195)	(12.2885)	(10.1611)	(-0.8604)	(6.6062)		(0.0000)

Table 3

Excess returns for R&D firms that differ in terms of dispersion in analysts' forecasts, analyst lack of consensus and analyst forecast uncertainty

The table reports the coefficient estimates and values of t-statistics (in parentheses) that have been estimated by running the following time-series regression using monthly data from July 1991-June 2004: (Rp-Rf) = alpha+ β_1(RM-Rf)+ +β_2SMB+β_3HML+β_4RDFactor+ε. (Rp-Rf) equals the difference between the equal-weighted monthly returns of three annually rebalanced dispersion (D), analyst lack of consensus (1-ρ) and analyst forecast uncertainty (V) portfolios, from low to high for R&D firms, and the risk free rate (1 month UK Treasury Bill rate). Dispersion, forecast uncertainty (V) and analyst lack of consensus (1-ρ) have been calculated as described in the paper, using minus one month prior to year end forecast data. (RM-Rf) equals the difference between the monthly value-weighted return of all the sample firms and the risk free rate. SMB equals the size factor, calculated by using the difference between the average equal-weighted monthly returns of three small and three large MVE portfolios: (SL+SM+SH)/3-(BL+BM+BH)/3. HML equals the value factor, defined as the difference between the average equal-weighted monthly returns between two high BM and two low BM portfolios:(SH+BH)/2-(SL+BL)/2. The R&D factor is calculated by taking the difference between the average monthly equal-weighted returns of three R&D reporting BM portfolios and three zero portfolios: (LRD+MRD+HRD)/3-(LZRD+MZRD+HZRD)/3. Panel A reports the results according to forecast dispersion portfolios. Panels B and C report the results according to analyst lack of consensus (1-ρ) and analyst forecast uncertainty (V) portfolios respectively. The regressions are run using OLS and Whites Heteroskedasticity robust standard errors. In the last column appear the F statistics and their p-values.

Panel A	alpha	RM	SMB	HML	RD Factor	Adj. R-squared	F-statistic
D1 (low)	0.0013	1.0532	0.3350	-0.0715	0.1595	0.6659	78.2473
	(0.5192)	(13.9677)	(3.8204)	(-0.7875)	(1.2593)		(0.0000)
D2	-0.0001	1.1039	0.4287	0.2079	0.3515	0.6357	68.6314
	(-0.0230)	(15.4551)	(4.9698)	(2.1307)	(2.1748)		(0.0000)
D3 (High)	0.0003	1.3748	0.8243	0.0351	0.5475	0.6946	89.1476
	(0.1005)	(16.5416)	(7.5964)	(0.3608)	(3.3664)		(0.0000)
Panel B							
(1-ρ)1 (low)	0.0032	1.1289	0.6026	-0.0304	0.4180	0.5895	56.6548
	(1.0028)	(12.1063)	(5.5455)	(-0.3009)	(1.9513)		(0.0000)
(1-ρ)2	0.0008	1.1683	0.3886	0.0284	0.3938	0.6955	89.4958
	(0.2917)	(16.5112)	(4.3098)	(0.2865)	(3.0830)		(0.0000)
(1-ρ)3 (High)	-0.0034	1.1649	0.5736	0.2071	0.2958	0.6845	85.0748
	(-1.3432)	(16.2835)	(5.9701)	(2.2728)	(2.4800)		(0.0000)
Panel C							
V1 (low)	0.0008	0.9962	0.1598	-0.0324	0.1253	0.6374	69.1309
	(0.3227)	(13.7473)	(1.9420)	(-0.3756)	(1.1097)		(0.0000)
V2	0.0008	1.1672	0.4542	0.0330	0.1718	0.6591	75.9129
	(0.2884)	(16.7509)	(4.1031)	(0.3323)	(1.0033)		(0.0000)
V3 (High)	-0.0008	1.3040	0.9126	0.2345	0.8225	0.6851	85.3025
	(-0.2593)	(14.5551)	(8.5597)	(2.3683)	(4.6206)		(0.0000)

Table 4

Excess returns for R&D intensive firms that differ in terms of dispersion in analysts' forecasts, analyst lack of consensus and analyst forecast uncertainty

The table reports the coefficient estimates and values of t-statistics (in parentheses) that have been estimated by running the following time-series regression using monthly data from July 1991-June 2004: (Rp-Rf) = alpha+ β_1(RM-Rf)+ +β_2SMB+β_3HML+β_4RDFactor+ε. (Rp-Rf) equals the difference between the equal-weighted monthly returns of three annually rebalanced dispersion (D), analyst lack of consensus (1-ρ) and analyst forecast uncertainty (V) portfolios, from low to high for R&D firms with an R&D/MVE ratio in the top quartile, and the risk free rate (1 month UK Treasury Bill rate). Dispersion, forecast uncertainty (V) and analyst lack of consensus (1-ρ) have been calculated as described in the paper, using minus one month prior to year end forecast data. (RM-Rf) equals the difference between the monthly value-weighted return of all the sample firms and the risk free rate. SMB equals the size factor, calculated by using the difference between the average equal-weighted monthly returns of three small and three large MVE portfolios: (SL+SM+SH)/3-(BL+BM+BH)/3. HML equals the value factor, defined as the difference between the average equal-weighted monthly returns between two high BM and two low BM portfolios: (SH+BH)/2-(SL+BL)/2. The R&D factor is calculated by taking the difference between the average monthly equal-weighted returns of three R&D reporting BM portfolios and three zero portfolios: (LRD+MRD+HRD)/3-(LZRD+MZRD+HZRD)/3. The table reports the results for the regressions run without an R&D factor and with the addition of the R&D factor. The firms employed have a December fiscal year end. Panel A reports the results according to forecast dispersion portfolios. Panels B and C report the results according to analyst lack of consensus (1-ρ) and analyst forecast uncertainty (V) portfolios respectively. The regressions are run using OLS and Whites Heteroskedasticity robust standard errors. In the last column appear the F statistics and their p-values.

Panel A: Fama-French time-series regressions for top R&D/MVE quartile firms according to three analyst forecast dispersion portfolios

	alpha	RM	SMB	HML	RD Factor	Adj. R-squared	F-statistic
D1 (low)	0.0033	1.0417	0.9318	0.3703	0.6772	0.3070	18.1646
	(0.6393)	(5.7289)	(3.4645)	(2.1137)	(1.9643)		(0.0000)
D2	0.0038	1.0834	0.3548	0.1882	0.4377	0.3644	23.2168
	(0.8387)	(10.8367)	(2.2545)	(1.1619)	(1.8993)		(0.0000)
D3 (High)	0.0064	1.4847	1.1873	0.1456	0.7376	0.5317	44.9911
	(1.3173)	(12.5427)	(6.5895)	(0.9142)	(2.5313)		(0.0000)

Table 4-cont'd

Panel B: Fama-French time-series regressions for top R&D/MVE quartile firms according to three analyst lack of consensus (1-ρ) portfolios

	alpha	RM	SMB	HML	RD Factor	Adj. R-squared	F-statistic
(1-ρ)1 (low)	0.0080	1.1566	0.5678	0.5005	0.6367	0.4513	32.8775
	(1.8112)	(11.3813)	(3.6474)	(3.5907)	(2.6562)		(0.0000)
(1-ρ)2	0.0080	1.2525	1.2443	0.2473	1.2862	0.3135	18.6984
	(1.1958)	(6.3273)	(2.8599)	(1.0268)	(2.1382)		(0.0000)
(1-ρ)3 (high)	0.0033	1.2420	1.1392	0.3125	0.6652	0.4267	29.8363
	(0.6763)	(9.2149)	(6.6832)	(1.8590)	(2.7613)		(0.0000)

Panel C: Fama-French time-series regressions for top R&D/MVE quartile firms according to three analyst forecast uncertainty V portfolios

	alpha	RM	SMB	HML	RD Factor	Adj. R-squared	F-statistic
V1 (low)	0.0089	0.6655	0.0710	0.1498	0.0458	0.2257	12.2977
	(2.2731)	(5.6684)	(0.6110)	(1.0204)	(0.2102)		(0.0000)
V2	0.0076	1.3576	1.7987	-0.0541	0.9928	0.3512	21.9724
	(1.0811)	(5.5432)	(3.9037)	(-0.2023)	(1.9088)		(0.0000)
V3 (high)	0.0040	1.2501	0.8124	0.3557	0.7590	0.4552	33.3741
	(0.8345)	(11.7099)	(5.0085)	(2.7822)	(2.9272)		(0.0000)